## Decision Rationale

## Total Maximum Daily Loads for the Aquatic Life Use Impairment on Holmans Creek and Muddy Creek

### I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited waterbody.

This document will set forth the Environmental Protection Agency's (EPA's) rationale for approving the TMDLs for the aquatic life use (benthic) impairment for Holmans Creek and Muddy Creek. EPA's rationale is based on the determination that the TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs include a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a margin of safety.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

### II. Background

The Holmans Creek and Muddy Creek watersheds are located in Rockingham County, Virginia. The Holmans Creek watershed is 11,988 acres in size. The Muddy Creek Watershed is 20,023-acres in size. The TMDLs address a 10.44 mile segment of Holmans Creek and a 10.36 mile segment of Muddy Creek. The Holmans Creek segment begins at its headwaters and terminates at its confluence with the North Fork of the Shenandoah River. The Muddy Creek segment begins at its headwaters and terminates at its confluence with the Dry River. Agricultural lands make up 55 percent of the 11,988 acre Holmans Creek Watershed. Residential and forested lands make-up an additional 41 percent of the watershed. Agricultural lands make up 61 percent of the Muddy Creek watershed. Developed and forested lands account for an additional 39 percent of the watershed.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 10.44 and 10.36 miles of Holmans Creek and Muddy Creek on Virginia's 1998 Section 303(d) list as being unable to attain the general standard for aquatic life use and being impaired by elevated levels of fecal coliform. Both streams were unable to attain either standard. The failure to attain the general standard for aquatic life use was determined through biological assessments of the benthic macroinvertebrate community. This decision rationale will address the TMDLs for the impairment of the aquatic life use. Separate decision rationales and TMDLs have been developed for the fecal coliform impairments on Holmans and Muddy Creeks. The fecal coliform TMDLs for Muddy and Holmans Creeks were submitted to and approved by EPA in 1999 and 2002 respectively.

Virginia 305(b)/303(d) guidance states that support of the aquatic life beneficial use is determined by the assessment of conventional pollutants (dissolved oxygen, pH, and temperature); toxic pollutants in the water column, fish tissue, and sediments; and biological evaluation of benthic community data.[1] Therefore, a biological assessment of the benthic community can be used to determine a stream's compliance with the state's general standard for aquatic life use. Virginia uses EPA's Rapid Bioassessment Protocol (RBPII) to determine the condition of a stream's benthic macroinvertebrate community.[2] This approach evaluates the benthic macroinvertebrate community between a monitoring site and its reference station. Measurements of the benthic community, called metrics, are used to identify differences between monitored and reference stations.[3]

Reference stations are established on streams which are minimally impacted by humans and have a healthy benthic community. Streams that are classified as moderately or severely impaired after an RBPII evaluation are classified as impaired and are placed on the Section 303(d) list of impaired waters. During the 1998 assessment period, both Holmans and Muddy Creeks were identified as being moderately impaired. Both streams continue to be assessed as impaired.

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[1]VADEQ. 1997. 1998 Water Quality Assessment Guidance for 305(b) Water Quality Report and 303(d) TMDL Priority List Report. Richmond, VA.

[2]Tetra Tech 2002. Total Maximum Daily Load (TMDL) Development for Blacks Run and Cooks Creek. Fairfax, Virginia.

[3]Ibid 2

The RBPII assesses the condition of the macroinvertebrate community of a stream. This analysis will inform the biologist if the stream's benthic community is impaired. However, it will not inform the biologist as to what is causing the degradation of the benthic community. A degraded community is generally seen as having a lower family diversity composed of species from pollutant tolerant families. Additional analysis is required to determine the pollutants which are causing the impairment. TMDL development requires the identification of impairment causes and the establishment of numeric endpoints that will allow for the attainment of designated uses and water quality criteria.[4]

A reference watershed approach was used to determine the stressors and the endpoints for these TMDLs. Numeric endpoints represent the water quality goals that are to be achieved through the implementation of the TMDL and will allow a stream to attain its designated uses. A reference watershed approach is based on selecting a non-impaired watershed that shares similar land use, ecoregion, and geomorphological characteristics with the impaired watershed.[5] The stream conditions and loadings in the reference stream are assumed to be the conditions needed for the impaired stream to attain standards.

To determine whether a stream was a suitable reference site for the monitored sites, the modelers evaluated the topography, soils, ecoregion, landuses, watershed size, and point source inventory of the potential reference watershed. All reference site candidates had to score slightly impaired or better in the biomonitoring analysis. It should be noted that there were no potential reference sites (unimpaired streams) with an urban landuse greater than six percent. The reference site selected for both streams was Hays Creek.

The TMDL modelers evaluated all of the streams against the Virginia Ridge and Valley Multimetric Bioassessment Index (VRVMBI) which was developed specifically for Virginia's Benthic TMDLs. This method evaluates the streams against a subset of the RBPII metrics and other data. For additional information on reference site selection or the VRVMBI, please see Section 2.3 of the TMDL document.

The next step in the TMDL development process was to determine the loadings and stressors in the monitored and reference watersheds. Dissolved oxygen (DO), sedimentation, nutrients, habitat modification, and toxic pollutants were evaluated as possible stressors to the monitored streams. Ambient water quality monitoring (AWQM) on all the streams documented temperature, DO, pH, turbidity, total suspended solids (TSS), ammonia, nitrates, total phosphorous, and fecal coliform concentrations. To get a better understanding of the daily DO concentrations, a diel DO analysis was conducted during the week of June 10, 2002. The summer

[4]Ibid 2

[5]Ibid 2

season is when one would expect the lowest DO concentrations to be found due to a combination of high water temperatures (lower solubility of oxygen) and low flows. DO concentrations and temperatures were evaluated over five-minute intervals for a 24-hour period each day. This data was extrapolated to document the daily DO cycles encountered around the AWQM station.

Toxicity testing was also conducted for water samples collected from the monitored sites. Water samples were collected from the impaired streams on June 3, 5, and 7, 2002. The tests compared the survival and reproduction rates of fathead minnows (*pimephales promelas*) and *Ceriodaphnia Dubia* in water collected from the impaired sites with the survival and reproduction rates of these same species in waters from an unimpaired source. The test did not document any adverse effects with the survival and growth of fathead minnows or the survival of *Ceriodaphnia Dubia* reared in water from Holmans or Muddy Creek. However, subchronic effects on the reproduction of *Ceriodaphnia Dubia* were observed in water from both Holmans and Muddy Creeks. Additional testing will be needed to verify these results and investigate possible toxic effects on aquatic organisms.

In general, the monitored sites had poorer water quality than the reference sites, (see Section 3.0 of the TMDL document for additional information). The analysis concluded that sedimentation was the problem on both Holmans and Muddy Creeks. Diel DO sampling observed depressed DO levels on both streams but they did not violate the criteria, except in the upper Muddy Creek Watershed. It should be noted that the diel DO analysis occurred at a time when violations would be more likely during the low flows and high temperatures of the summer. DO was not seen as a factor on Holmans Creek or the lower Muddy Creek. Low DO levels associated with organic enrichment was seen as a problem in the upper Muddy Creek Watershed. AWQM data indicating elevated levels of TSS and turbidity on both monitored sites identified excessive sedimentation as a stressor to both streams. Habitat alteration (lack of riparian buffers) was also seen as a problem on both streams but not specifically included in the TMDL.

The next step in developing these TMDLs was to determine the loadings of phosphorous (upper Muddy Creek) and sediment (the stressors) to the monitored and reference segments. The Generalized Watershed Loading Functions (GWLF) model was selected as the means to determine loadings to the streams. The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[6] GWLF is a continuous simulation model that uses daily time steps for weather data and water balance calculations.[7] Monthly calculations are made for sediment and nutrient

[6]Ibid 2

[7]Ibid 2

loads, based on daily water balance totals that are summed to give monthly values.[8] To equate the reference watersheds with the monitored watersheds, the reference watersheds were reduced in size to that of the impaired watershed in the model, the landuses were proportionally reduced based on the percent landuse distribution. Therefore, the landuse breakdown in the reference watersheds remained constant.

Local rainfall and temperature data were needed to simulate the hydrology. The Dale Enterprise weather station was used for temperature and precipitation data for Holmans and Muddy Creeks. The Lexington (temperature) and Kerrs Creek (precipitation) weather stations were used for the Hays Creek model. Since there was no gage on Hays Creek, the hydrology calibration for Hays Creek was transferred from Kerrs Creek. Holmans Creek did not have a gage recording daily stream flow measurements. Therefore, it was necessary to model the hydrology of nearby Linville Creek and transfer that model to Holmans Creek. United States Geological Survey gage 01621050 is located in Mount Clinton, VA on Muddy Creek this gage was used to model stream flow of the impaired segment (for additional information on modeling, see Section 5 of the TMDL report).

Table 1 - Summarizes the Specific Elements of the TMDLs.

| Segment | Parameter | TMDL (lbs/yr) | WLA (lbs/yr)** | LA (lbs/yr) | MOS (lbs/yr)* |
|---|---|---|---|---|---|
| Holmans Creek | Sediment | 8,247,444 | 78,144 | 7,408,399 | 824,744 |
| Muddy Creek | Sediment | 12,894,406 | 286,939 | 11,318,026 | 1,289,441 |
| Muddy Creek upper segment | Phosphorous | 6,088 | 38 | 5,441 | 609 |

* Virginia includes an explicit MOS by reserving the 10 percent of total loading to the MOS.
* WLA is equal to the permitted discharge from all facilities minus in stream losses.

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

## III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing aquatic life use (benthic) impairment TMDLs for Holmans and Muddy Creeks. EPA is therefore approving these TMDLs. Our approval is outlined according to the regulatory requirements listed below.

*1) The TMDL is designed to meet the applicable water quality standards.*

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[8] Ibid 2

The monitored sites were listed as impaired due to a degradation of the benthic macroinvertebrate community. As mentioned above, benthic assessments inform the biologist of an impairment, but they are unable to identify a stressor. Therefore a reference watershed approach was used to identify the stressors to these streams. Virginia has indicated that excessive levels of sediment and phosphorous have caused the degradation of the benthic community on the upper portion of Muddy Creek, while sediment alone was seen as the pollutant of concern on Holmans and the lower portion of Muddy Creek. The Commonwealth does not have numeric standards for either nutrients or sediment. Therefore, the loading obtained from the reference watershed was used as the TMDL endpoint. Its believed that if these loadings are obtained, that the impairment to the benthic community will be relieved.

The GWLF model was used to determine the loading rates of sediment and phosphorous from the land as well as loadings to the stream from direct deposit sources. The TMDL modelers determined the sediment and phosphorous loading rates within each watershed. Data used in the model was obtained on a wide array of items, including farm practices in the area, the amount and concentration of farm animals, point sources in the watershed, wildlife in the watershed, landuses, weather, stream geometry, etc..

The GWLF model provides the ability to simulate runoff, sediment, and nutrient loadings from watersheds given variable source areas (e.g., agricultural, forested, and developed land).[9] GWLF is a continuous simulation model that uses daily time steps for weather data and water balance calculations.[10] To equate the reference watershed with the monitored watersheds, the reference watershed was reduced in size in the model. Each landuse was reduced in equal proportion, insuring that the landuse breakdown in the reference watershed remained constant. Local rainfall and temperature data were needed to simulate the hydrology, this data was obtained from different sources for each watershed. In the GWLF model, the nonpoint source load calculation is affected by terrain conditions, such as the amount of agricultural land, land slope, soil erodibility, farming practices used in the area, and background concentrations of nutrients in soil and groundwater.[11] Parameters within the model account for these conditions and practices and were adjusted to insure that the hydrology and water quality calibrations matched the observed conditions as closely as possible.

EPA believes that using GWLF to model and allocate sediment and phosphorous loadings to the monitored segments will ensure that the designated uses and water quality standards will be attained and maintained on these streams.

*2 ) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.*

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[9]Ibid 2

[10]Ibid 2

[11]Ibid 2

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of nutrients and sediment to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

Virginia has stated that there are six permitted point sources discharging to Holmans Creek and 15 permitted point sources discharging to Muddy Creek. Four of the six facilities discharging to Holmans Creek are single family home waste water treatment facilities. A quarry and orchard represent the other two point sources. Thirteen of the 15 facilities in the Muddy Creek Watershed were single family home units. The remaining facilities on Muddy Creek are a slaughter house and a small treatment unit. The single family home units are covered by a Virginia Pollutant Discharge Elimination System general permit. The general permit calls for a TSS limit of 30mg/L and a flow of less than or equal to 1,000 gallons per day. The annual sediment loading from these facilities can be found in Table 2a, and was calculated by multiplying the concentration of sediment by the design flow. Only one of these facilities was required to have a phosphorous allocation since it was the only point source in the upper segment of Muddy Creek. Table 2b documents the phosphorous loading which is based on an effluent concentration of 15 mg/L.

None of the facilities were required to reduce their current sediment or phosphorous loads since their loads were such a small portion of the total loading. Point source contributions, even in terms of maximum flow were minimal. The sediment load from point sources accounted for 1 percent and 2 percent of the total loading on Holmans and Muddy Creek respectively. These facilities are often discharging below their numeric effluent limit for TSS of 30 mg/L meaning their loading is actually below their allocation. The largest point source discharger, Pilgrims Pride, was required to adjust its nitrogen loading as part of the Muddy Creek nitrate TMDL. The reductions called for in the Nitrate TMDL were not factored into the sediment TMDL even though the treatment used to achieve the nitrogen reductions may lower the TSS load as well.

EPA regulations require that an approvable TMDL include individual wasteload allocations (WLAs) for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), “Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7.” Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Table 2a - TSS Permitted discharges for Holmans and Muddy Creeks

| Stream | Facility | Permit Number | TSS (lbs/yr) |
|---|---|---|---|
| Muddy Creek | Pilgrims Pride | VA0002313 | 329,318 |
| Muddy Creek | Calvary Menonite Fellowship | VA0062928 | 1,207 |
| Muddy Creek | Single Family House | VAG401208 | 92 |
| Muddy Creek | Single Family House | VAG401808 | 92 |
| Muddy Creek | Single Family House | VAG401132 | 92 |
| Muddy Creek | Single Family House | VAG401540 | 92 |
| Muddy Creek | Single Family House | VAG401829 | 92 |
| Muddy Creek | Single Family House | VAG401830 | 92 |
| Muddy Creek | Single Family House | VAG401833 | 92 |
| Muddy Creek | Single Family House | VAG401448 | 92 |
| Muddy Creek | Single Family House | VAG401246 | 92 |
| Muddy Creek | Single Family House | VAG401741 | 92 |
| Muddy Creek | Single Family House | VAG401412 | 92 |
| Muddy Creek | Single Family House | VAG401890 | 92 |
| Muddy Creek | Single Family House | VAG401466 | 92 |
| Holmans Creek | C.S. Mundy Quarries | VAG841022 | 91,389 |
| Holmans | Wunder Orchards | VA0088285 | 684 |
| Holmans Creek | Single Family House | VAG401541 | 92 |
| Holmans Creek | Single Family House | VAG401958 | 92 |
| Holmans Creek | Single Family House | VAG401349 | 92 |
| Holmans Creek | Single Family House | VAG401809 | 92 |

Table 2b - Phosphorous WLAs for Muddy Creek

| Stream | Facility | Permit Number | Allocated Load (lbs/yr) |
|---|---|---|---|
| Muddy Creek | Single Family Unit | VAG401448 | 46 |

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), load allocations (LAs) are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, Virginia Department of Environmental Quality used the GWLF model to represent the impaired watersheds. The GWLF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. GWLF uses precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various land uses within the watershed. Table 3a through 3c document the load allocations for Holmans and Muddy Creeks.

Table 3a - LA for Sediment for Holmans Creek

| Landuse | Existing Load (lbs/yr) | Allocated Load | Percent Reduction |
|---|---|---|---|
| Row Crops | 4,968,880 | 3,478,176 | 30 |
| Pasture/Hay | 4,750,276 | 3,383,622 | 29 |
| Forest | 69,628 | 69,628 | 0 |
| Urban (grouped pervious and impervious areas) | 351,750 | 246,225 | 30 |
| Transitional | 556,358 | 166,907 | 70 |
| Water | 0 | 0 | 0 |
| Groundwater | 0 | 0 | 0 |
| Point Sources | 78,141 | 78,141 | 0 |
| Septic Systems | 0 | 0 | 0 |
| Total Existing Load | 10,775,034 | 7,422,699 | |

Table 3b -LA for Sediment Muddy Creek

| Landuse | Existing Load (lbs/yr) | Allocated Load (lbs/yr) | Percent Reduction |
|---|---|---|---|
| Row Crops | 22,989,568 | 7,998,070 | 73 |
| Pasture/Hay | 5,951,648 | 2,288,868 | 70 |
| Transitional | 943,458 | 377,383 | 70 |
| Forest | 104,409 | 104,409 | 0 |
| Urban (grouped pervious and impervious) | 915,491 | 549,295 | 40 |
| Water | 0 | 0 | 0 |
| Groundwater | 0 | 0 | 0 |
| Point Sources | 286,939 | 286,939 | 0 |
| Septic Systems | 0 | 0 | 0 |
| Total | 31,191,513 | 11,604,964 | |

Table 3c - LA for Phosphorous for Muddy Creek

| Landuse | Existing Load (lbs/yr) | Allocated Load (lbs/yr) | Percent Reduction |
|---|---|---|---|
| Row Crops | 10,390 | 2,792 | 73 |
| Pasture/Hay | 4,119 | 1,232 | 70 |
| Transitional/Barren | 237 | 71 | 70 |
| Forest | 33 | 33 | 0 |
| Urban (grouped pervious and impervious) | 845 | 507 | 40 |
| Groundwater | 740 | 740 | 0 |
| Point Sources | 38 | 38 | 0 |
| Septic Systems | 128 | 64 | 50 |
| Water | 0 | 0 | 0 |
| Total | 16,530 | 5,477 | |

*3) The TMDL considers the impacts of background pollution.*

The state has included natural background as a component of the LAs, as required by 40 CFR §130.2(g). There are two separate considerations of background pollutants within the context of these TMDLs. First, there is the inherent assumption of the Reference Watershed approach that because of the similarities between the reference and impaired watershed, the background pollutant contributions will be similar. Therefore, the background pollutant contributions will be considered when determining the loads for the impaired watershed which are consistent with the loads from the reference watershed. Secondly, the GWLF model implicitly considers background pollutant contributions through the groundwater component of the model process.

*4) The TMDL considers critical environmental conditions.*

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the Holmans and Muddy Creeks is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[12]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios. By using the GWLF model, the modelers insured that all flow conditions were taken into account for loading calculations by modeling the TMDL over an extended period of time. This in turn insures that the model was developed to address critical conditions.

*5) The TMDLs consider seasonal environmental variations.*

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. Consistent with our discussion regarding critical conditions, the GWLF model and TMDL analysis effectively considered seasonal environmental variations through the use of observed weather data. The model also accounted for the seasonal variation in loading by adjusting the vegetative cover and manure application rates based on the

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[12]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

time of year.  For example, vegetative cover was lower during the winter months.

*6)  The TMDLs include a margin of safety.*

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty.  The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL.  Virginia includes an explicit MOS by allocating ten percent of the total TMDL loading to the MOS.

*7)  There is a reasonable assurance that the TMDL can be met.*

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process.  According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA.  Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.  Additionally, Virginia's Unified Watershed Assessment, an element of the Clean Water Action Plan, could provide assistance in implementing this TMDL.

The TMDL in its current form is designed to meet the applicable water quality standards. The Commonwealth intends to implement this TMDL through best management practices (BMPs). The implementation of these practices will occur in stages.  This will allow the Commonwealth to monitor the benefits of the BMPs and determine which practices have the greatest impacts on water quality.  It will also provide a mechanism for developing public support and checking the accuracy of the model.

*8)  The TMDLs have been subject to public participation.*

Two public meetings were held to discuss TMDL development on Holmans and Muddy Creeks.  Both of these meetings were public noticed in the *Virginia Register* and opened to a thirty-day comment period.  The first meeting was noticed in the *Virginia Register* on April 22, 2002 and held on May 2, 2002 in VADEQ's Regional Office in Harrisonburg, VA.  Seven people attended this initial meeting on the TMDL.  Eleven people attended the second meeting which was noticed on July 15, 2002 and held at VADEQ's Harrisonburg Office on July 23, 2002.  There were no written comments associated with either of these meetings.